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ORDER CODE FOR THE UNIVERSITY OF ILLINOIS

DIGITAL COMPUTER

1. Introduction. The University of Illinois electronic digital computer is a machine with a register capacity of 40 binary digits and an electrostatic memory which can hold 1024 40-digit words. The arithmetic unit handles 39 binary digits and sign, acts in the range $-1 \leq x < 1$, and uses complementation with respect to 2 for negative numbers.

There are four registers to be considered,

a. R_1, the accumulator,

b. R_2, the quotient register,

c. S^3, the memory register,

d. R_3, the order register.

Each of the first three registers holds a number consisting of sign and 39 binary digits. The accumulator and quotient register (hereafter called registers) can shift either left or right. The shift order is of the form 2^{+k}, 2^{+2k}, ..., 2^{+30k}, (or 2^{-k}, 2^{-2k}, ..., 2^{-30k}) where 2^k is the shift.

The memory consists of 1024 forty-digit words. Since 40 digits are not required for an order, two orders are packed into each word. The right hand order is executed first. The memory is addressed by the number in the memory register. One can distinguish between orders and numbers only by the way they are used. Transfer of information from memory to R_3, the normal procedure before executing an order, takes 30 microseconds. Transfer from memory to the other registers takes 60 microseconds. Transfer from the registers to memory takes 60 microseconds. Orders are executed in the order they appear in memory except for control transfer orders.

In the arithmetic operations the location of the binary point is assumed to be as follows.

2. The Makeup of Orders. Each 36 memory bits can be used as an instruction or as an address. The instruction word is divided into 2 digits and the address bits for the remaining 24 digits.

The address digits usually refer to the memory but they may be used for other purposes if no memory reference is required.

For reasons associated primarily with the Teletype equipment used for input and output to the computer it is designed to use a pseudo-octal or base 16 number system. In this system one hexadecimal character is used in place of four binary digits and one 6 binary instruction digit can be represented by 2 hexadecimal digits. The arbitrary characters used to represent the numbers 10, 11, 12, 13, 14 and 15 of the decimal system are K, S, N, J, F and L respectively. For example, the instruction digits 0111 1101 would be written 7J.

The two hexadecimal instruction digits will be called A and B. The A digit specifies the type of order and the B digit qualifies and variations of that type.

3. Order Types. There are 13 types of orders given by the A-digits as shown in Table 1.

Table 1. Order Types

A DIGIT	TYPE OF ORDER
0	Left Shift
1	Right Shift
2	Unconditional Transfer
3	Conditional Transfer
4	Store or Address
5	Memory to Quotient Register
6	Device
7	Arithmetic

C	Punch or Collate
9	Letter Output
S	Addition from Quotient Register
J	Subtract
L	Addition

b. Order Variations: The D Digit. The number of variations of orders is quite large, and it is not practicable to enumerate all of them. What we shall do is to show how one's imagination is focused on them to give a list of the more common and useful ones.

The four binary digits $D8$, $D4$, $D2$, and $D1$ of the D digit are given in Table 2. There are, of course, 16 possible combinations of these digits, but not all of them are used and, indeed, some of them will cause the machine to do unwanted operations and must be avoided.

Table 2. ORDER VARIATIONS: THE D DIGIT

ROUNDOFF	ADD, SUBTRACT, TEST ORDER	ABSOLUTE VALUE, OPTION, NOT TEST	CLEAR ACCUMULATOR
1	1	1	1
- B8 -	- B4 -	- B2 -	- B1
0	0	0	0
NOT ROUNDOFF	SUBTRACT TAPE SELECT ORDER	MINUS ONLY TEST	NO CLEAR ACCUMULATOR

The results obtained with different D digits are as follows:

a. The Digit B1. If B1 = 1, the accumulator R_2 will be cleared at once at the beginning of any order. If B1 = 0, the accumulator will not be cleared.

b. The Digit B8. If B8 = 1 and if B4 = 1, the quantity 2^{39} will be put into the accumulator at the beginning of the order. This is the way in which rounded multiplication is performed. If B8 = 1 and B4 = 0, the machine will stop.

c. The Digit D2 This digit affects all orders except the A, I, S, and J orders. The variations are given in Table 4.

d. The Digit D1 This digit affects all orders except the A, S, and J orders. The variations are given in Table 5.

5. The Address Digits of an Order The rightmost 30 binary digits of each order specify an address. This address usually refers to a location in the memory, but this is not always so. The address can vary from 0 to 1023. Table 3 gives the function of the address.

Table 3. Meaning of Address Digits

ORDER	ADDRESS SPECIFICATION
0,1	Number of shifts, n ($n \leq 63$)
2,3	Memory location from which next order will come
4	Memory location at which Margin Fill occurs
5	Memory location from which word is brought to control register
6	Memory location of dividend
7	Memory location of multiplicand
80,82	Number of binary digits to be [illegible] to be multiple of 3. See text.
92	Specifies character and number of blanks to be punched.
S	Address not used.
J	Same as for S order.
A	Memory location of address.

The drum writes will require special attention because the location of an address on the drum will change as card is [illegible]. This will be done by always writing the next word in the order list of cells in the address zone of the drum memory corresponding to the accompanying card order. In this way there will be a first word, next one and the [illegible]

ORDER TYPE	B4	EFFECT OF B4	B2	EFFECT OF B2
0, 1 Shift	--	No effect	--	No effect
2, 3 Transfer	0	Transfer to right hand order.	0	If panel switch is set to RUN, machine will stop before transferring control.
	1	Transfer to left hand order.	1	No effect
4 Store Address	--	No effect	0	Store order.
	0	Right hand address	1	Address Order
	1	Left hand address		
5, J Memory to R_2	--	No effect	--	No effect
6 Divide	1	No effect	1	No choice
7 Multiply	1	No choice	0	No choice
8 Drum, Tape	0	Tape	0	Input
	1	Drum	1	Output
9 Lesser Output	0	Tape	1	Output
S_1 ... Addition type	0	Subtract	0	Use number in memory or R_2
	1	Add	1	Use absolute value of number in memory or R_2

Table 6. Summary of Control

f. 5B n. [illegible]

g. 6B n. [illegible]

h. 7B n. MULTIPLY [illegible]

i. 8B n. [illegible]

j. 9B n. LETTER OUTPUT Punch on the tape a character depending upon the address digits n. The contents of R_3 and R_2 will [illegible] right shifts will be executed for each letter output. [illegible] it possible to punch any of the 32 combinations of 5 holes on the output tape. Three quantities are derived [illegible]

(1) The leftmost 4 digits define [illegible] output tape.

(2) The rightmost address digit defines the [illegible] tape.

(3) The rightmost 6 digits of the address [illegible] b of times that the character defined above is punched, and also the number of right shifts performed by this order. The number c is determined as follows:

$$n = 6b + 4 + c, \quad 0 \le c \le 3$$

where c determines the [illegible]

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